# The Demand and Financial Cost of Hospital Care for Diabetes Mellitus and its Related Complications

The study of healthcare resource use in diabetes is inherently challenging for a variety of reasons, including the insidious onset of Type 2 diabetes; the diverse range of vascular complications that can result from all forms of diabetes; and the complexity of multiple and inter-related risk associations. These factors in combination with shortcomings in hospital and primary care information systems have impeded progress in our understanding of the demand for hospital services for the treatment of those with diabetes. There has been a particular lack of hard data estimating the secondary care costs of treating diabetes-related vascular complications. The shortcomings of typical NHS data include the inconsistent identification of patients with primary pathologies and coexisting diabetes, an inability to identify records that relate to the same individuals, and, until recently, the absence of any routine mechanism of estimating the cost associated with any single episode of care. A number of investigators had attempted to inform others of the high demand and thus cost of treatment for those with diabetes. Much of the earlier work describing the costs of diabetes in the UK was eloquently summarized by Laing and Williams,[1] and a summary statistic of 4–5 % of NHS resources was then widely quoted as the proportion of NHS finances devoted to the treatment of patients with diabetes. In addition to the deficiencies in routine NHS data described above, the authors recognized important gaps such as the absence of a detailed description of the treatment of patients with diabetes in outpatient clinics in specialties other than diabetes clinics.

In 1994, a number of local conditions and general developments in the use of routine hospital data led us to believe that we could attempt to make a more reliable estimate of the cost of treating diabetes. We had comprehensive hospital data for the population as well as a number of additional sources of information that could collectively identify the majority of patients with diagnosed diabetes. These included an ongoing study of diabetes care in general practice that involved audit staff visiting and collating data related to those with diabetes.[2,3] The wider developments included the development of hospital record linkage algorithms, for example, the Oxford Record Linkage Study,[4] and iso-resource grouper software (diagnosis related groups (DRGs), and now healthcare resource groups (HRGs)). Collectively, when applied together, we felt that these methods would allow us to achieve the identification of the majority of people with diabetes in the population, quantification of all of their secondary care clinical contacts both as inpatients and outpatients, and then allow estimation of the financial cost to each recorded inpatient event. The audit of diabetes in general practice offered another advantage in providing a valid source of data describing age- and sex-specific diabetes prevalence values for use in the calculation of event rates.

After the application of these methods a surprising picture emerged which suggested that previous methods had underestimated the activity related to diabetes to a notable degree. Our methods allowed us to describe the pattern of inpatient and outpatient care for those with diabetes;[5] to then estimate the present, future, and excess costs of care;[6] and give detailed descriptions of the patterns and cost of care for diabetes vs non-diabetes coronary heart disease,[7] cerebrovascular disease,[8] and those conditions that collectively constitute 'the diabetic foot'.[9] The most important summary statistic to arise from these studies was a revision of the cost of hospital treatment for those with diabetes to 9 % of secondary care revenue resulting from the occupancy of 11 % of secondary care bed-days.[6]

We would suggest that the results generated in these studies were reliable. At an early stage we tested the specificity of a diagnosis of diabetes. The diagnosis proved to be correct in 69 of 70 cases.[5] Almost exactly the same specificity was found in the Diabetes Audit and Research in Tayside Scotland study (DARTS study), which employs record linkage methods.[10] We then tested to see if the greatly increased diabetes-related admission rates evident in all categories of vascular disease were also increased in a mixed-bag of diagnoses that were not considered to be related to diabetes, for example, appendicitis and hernia. They were not.[5] One concern was the quality of local data collected routinely. However, we had empirical evidence that this was of an acceptably high standard[11,12] and any problems associated with coding more 'exotic' diagnoses were likely to appear with equal frequency in both the diabetic and non-diabetic populations.

A number of theoretical problems existed in relation to the validity of cost attribution in these studies. Costs were attributed to the population with diabetes. Almost all of the costs quoted could have been equally attributed to other disease groups. For example, the cost of an admission for a patient diagnosed with a myocardial infarction who had co-existing Type 2 diabetes could be attributed to both coronary heart disease (CHD) or diabetes. In a hypothetical parallel study with the primary

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CCC 0742–3071/98/060449–03$17.50

objective of costing those in the population with heart disease, this admission would rightly be included in the CHD group. If one were to sum all separate cost analyses, this multiple counting would result in health expenditure far greater than reality. We therefore applied a technique to estimate the *excess* cost of the disease, that is, the cost over and above that expected if the population of people with diabetes had the same health experiences as those in the non-diabetic population. This eliminated the double counting effect. The extra cost burden created by diabetes as the predisposing condition is a staggering 80 % or more.[6]

The other interesting theoretical—and as yet unresolved—issue relating to cost attribution in these studies was the way in which we dealt with subsidiary diagnoses, since all routine records have the facility to record up to six diagnoses. In the event we used upper and lower estimates depending on whether the ICD diagnostic code was a primary or secondary code. All things considered, we feel that we have tested the methods vigorously and that the cost estimates are valid. We have, however, discussed the potential for misrepresenting descriptive epidemiology in these types of study for a disease where there is uncertainty relating to the proportion of people whose diabetes remains undiagnosed.[13] This problem is not only restricted to data presented in our studies but extends to all rate calculations where a valid denominator representing the prevalence of diabetes is required and no systematic screening programme is in place to identify all patients who have diabetes using strict diagnostic criteria. This issue will become more contentious following the general acceptance of lower thresholds for the biochemical diagnosis of diabetes mellitus.[14]

How can 'economic' studies like these help? A single subpopulation with a prevalence of 2 % incurring costs that exceed 9 % of revenue is clearly an important patient group. These are not simply cost of illness studies since a very large proportion of this expenditure is related to complications that are to some extent preventable. Ample evidence now exists to illustrate that lifestyle changes combined with a cocktail of pharmacological interventions can prevent both primary and secondary vascular events, particularly cardiac events. Data from activity and cost studies such as ours, although not strictly a cost–benefit analysis (and never intended to be), fuels this debate by providing a better description of the order of magnitude of the potential savings that can be made by preventing or delaying the onset of these morbid events. Summary findings were used by the British Diabetic Association in their commissioned publication on the impact of Type 2 diabetes, *Counting the Cost*.[15]

Most commentaries describing the epidemiology of diabetes focus on only one particular type of diabetes-related complication, often from a very specialist perspective. The methods described allow the comparison of data relating to all macrovascular groups of complications using data from the same population and over the same time period. They also permit comment on the relative impact of complications in terms of case severity, procedure rates, hospital case fatality, and other outcome measures without having to account for the underlying effects of bias and assumptions inherent in the comparison of unrelated studies. The work also demonstrates for the first time a reproducible model that allows estimation of the cost of other complex chronic disease using routine NHS statistics. Finally, it provides better, more reliable and comprehensive base data to populate theoretical economic models that are being increasingly used to predict outcome and/or cost-effectiveness of interventions in health care.[16,18]

**Acknowledgements**

We would like to thank the British Diabetic Association (BDA) for funding this work.

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## References

1. Laing W, Williams R. *Diabetes*. London: Office of Health Economics, 1989.
2. Butler C, Peters JR, Stott N. Glycated haemoglobin and metabolic control of diabetes mellitus: external versus locally established clinical targets. *Br Med J* 1995; **310**: 784–788.
3. Butler C, Smithers M, Stott N, Peters J. Audit-enhanced, district wide primary care for people with diabetes mellitus. *Eur J Gen Pract* 1996; **3**: 23–27.
4. Gill L, Goldacre M, Simmons H, Bettley G, Griffith M. Computerized linking of medical records: methodological guidelines. *J Epidemiol Community Hlth* 1993; **47**: 316–319.
5. Currie CJ, Williams R, Peters JR. Patterns of in- and outpatient activity for diabetes: a district survey. *Diabetic Med* 1996; **13**: 273–280.
6. Currie CJ, Kraus D, Gill L, Stott NCH, Peters JR. NHS acute-sector expenditure for diabetes—the present, future, and excess inpatient cost of care. *Diabetic Med* 1997; **14**: 686–692.
7. Currie CJ, Morgan CL, Peters JR. Patterns and costs of diabetes and nondiabetes related coronary heart disease hospital care. *Heart* 1997; **78**: 544–549.
8. Currie CJ, Morgan CL, Gill L, Stott NCH, Peters JR. The epidemiology and costs of acute hospital care for cerebrovascular disease in diabetic and non-diabetic populations. *Stroke* 1997; **28**: 1142–1146.
9. Currie CJ, Morgan CL, Peters JR. The epidemiology and cost of hospital care for peripheral vascular disease, infection, neuropathy and ulceration. *Diabetes Care* 1998; **21**: 42–48.
10. Morris AD, Boyle DIR, MacAlpine R, Emslie-Smith A, Junj RT, Newton RW, Macdonald TM for the DARTS/MEMO Collaboration. The diabetes audit and research in Tayside Scotland (DARTS) study: electronic record linkage to create a diabetes register. *Br Med J* 1997; **315**: 524–528.

11. Anonymous. *Llandough Hospital Data Audit Project*. Cardiff: Health Intelligence Unit, Welsh Health Common Services Authority, Welsh Office, August 1992.
12. Wilkinson EJ, Harvey I. Accuracy of hospital diagnostic and operative procedure costing. In: *Commentaries on Health Services*. Cardiff: South Glamorgan Health Authority, August 1992.
13. Currie CJ, Peters JR. True population prevalence of diabetes: limitations and risks of estimation. *Diabetic Med* 1997; **14**: 477–481.
14. Anonymous. *World Health Report, 1997*. Geneva: World Health Organization, 1997.
15. Marks L. *Cost of Diabetes*. London: British Diabetic Association and King Edward's Hospital Fund for London, 1997.
16. Kiberd BA, Jindal BB. Screening to prevent renal failure in insulin dependent diabetic patients: an economic evaluation. *Br Med J* 1995; **311**: 1595–1599.
17. Gagliardino JJ, Olivera EM, Barragan H, Puppos BA. A simple economic evaluation model for screening diabetes health care strategies. *Diabetic Med* 1993; **10**: 351–354.
18. Eastman RC, Javitt JC, Herman WH, Dasbach EJ, Copley-Merriman C, Maier W *et al*. Model complications of NIDDM. II. Analysis of the health benefits and cost-effectiveness of treating NIDDM with the goal of normoglycaemia. *Diabetes Care* 1997; **20**: 735–744.



 